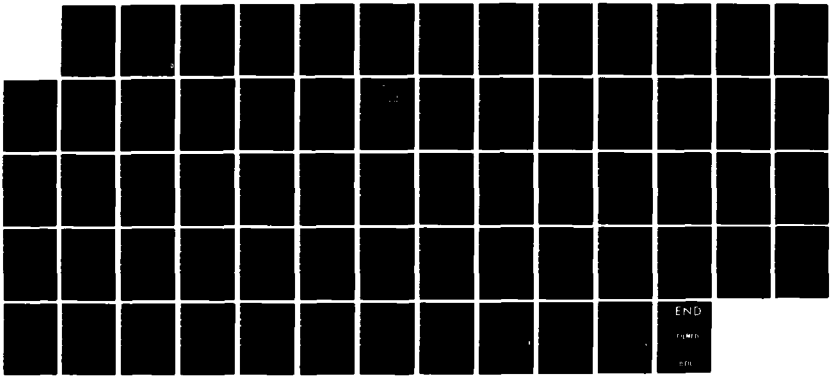
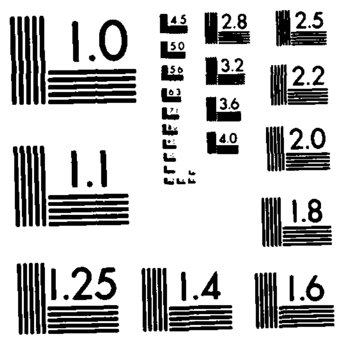
AD-A154 474   SOLID WASTE RESOURCE ALTERNATIVES U S FACILITY SUBIC   1/1
BAY PHILIPPINES(U) NAVAL CIVIL ENGINEERING LAB PORT
HUENEME CA S A VIGIL ET AL. MAR 85 NCEL-TN-1721

UNCLASSIFIED   F/G 13/2   NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TECHNICAL NOTE

TN NO: **N-1721**

TITLE: SOLID WASTE RESOURCE RECOVERY ALTERNATIVES, U. S. FACILITY, SUBIC BAY, PHILIPPINES

AUTHOR: S. A. Vigil, Civil and Environmental Engineering Department, California Polytechnic State University, San Luis Obispo, California
and R. M. Roberts, D. E. Brunner

DATE: March 1985

SPONSOR: Naval Facilities Engineering Command

PROGRAM NO: YO817-004-01-213

NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA 93043

METRIC CONVERSION FACTORS

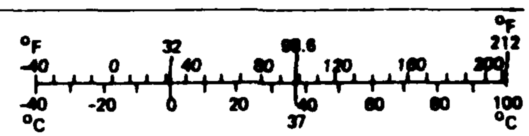
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TN-1721	2. GOVT ACCESSION NO DN787114	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) SOLID WASTE RESOURCE ALTERNATIVES, U. S. FACILITY, SUBIC BAY, PHILIPPINES		5. TYPE OF REPORT & PERIOD COVERED Final; Jun 1983 – Feb 1984
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) S. A. Vigil, CalPoly Univ., San Luis Obispo, Calif., R. M. Roberts and D. E. Brunner (NCEL)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS NAVAL CIVIL ENGINEERING LABORATORY Port Hueneme, California 93043		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 63721N; YO817-004-01-213
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Facilities Engineering Command Alexandria, Virginia 22332		12. REPORT DATE March 1985
		13. NUMBER OF PAGES 60
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS (of this report) Unclassified
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Subic Bay, solid waste management, resource recovery, waste to energy, heat recovery incinerator

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Seven alternative systems for improving waste management at the U. S. Facility, Subic Bay, were studied. A semi-mechanized recycling facility with baling or a heat recovery incinerator was recommended.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Library Card

Naval Civil Engineering Laboratory
SOLID WASTE RESOURCE ALTERNATIVES, U. S. FACILITY, SUBIC BAY, PHILIPPINES (Final), by S. A. Vigil, R. M. Roberts, and D. E. Brunner
TN-1721 60 pp illus March 1985 Unclassified

1. Solid waste management 2. Resource recovery I. YO817-004-01-213

Seven alternative systems for improving waste management at the U. S. Facility, Subic Bay, were studied. A semi-mechanized recycling facility with baling or a heat recovery incinerator was recommended.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

CONTENTS

Page

Section 6. CAPITAL AND OPERATING COST COMPARISON

SECTION 7. RECOMMENDATIONS AND CONCLUSIONS

Page

Section 1

INTRODUCTION

The U.S. Navy Public Works Center, Subic Bay, Republic of the Philippines (PWC Subic Bay) is responsible for the collection and disposal of almost 300,000 yd^3 of solid waste annually. A portion of this solid waste is manually sorted and recycled, resulting in gross revenues of over $200,000 in FY82. The present manual sorting and recycling system is considered by PWC Subic Bay to be inadequate in terms of sanitation, safety, and recyclable materials recovery. Therefore, PWC Subic Bay requested that the Naval Civil Engineering Laboratory (NCEL) study the system and recommend improvements.

OBJECTIVES

The specific purpose of this study was to evaluate the existing solid waste management and resource recovery system and identify methods which will meet the following objectives:

1. Enhance the physical security of the base by making the residual landfilled material unattractive to scavengers.

2. Safeguard the rights of the contract employees while improving their safety, working conditions, and productivity.

3. Improve the habitability and cleanliness of the base in the vicinity of the recycling facility.

4. Increase net revenues to PWC Subic Bay by increasing the proportion of material recycled, improving the quality of recovered materials, and extracting the energy available in the residuals destined for disposal.

SCOPE

The report examines present solid waste management practices at PWC Subic Bay and provides an estimate of solid waste processed and materials recovered. An estimate of potential recoverable energy from this waste stream is then made and compared to the electrical and steam loads of the base. Several alternative recycling and energy recovery alternatives are then considered. Finally a comparative analysis of these systems is performed and a recommended system described.

Section 2

PRESENT SOLID WASTE MANAGEMENT PRACTICES

PWC Subic Bay provides all public works and utility support services to the U.S. Facility, Subic Bay. One essential service provided is collection, processing, and storage of base solid wastes. This section provides an overview of the U.S. Facility, Subic Bay, and describes current solid waste management practices. It is based on the PWC Subic Bay Solid Waste Improvement Plan (Ref 1) and an on-site inspection by the authors on 27 June through 30 June 1983.

OVERVIEW OF THE U.S. FACILITY, SUBIC BAY

The U.S. Facility, Subic Bay consists of seven major commands including: U.S. Naval Station (NAVSTA); U.S. Navy Public Works Center, Subic Bay (PWC Subic Bay); U.S. Naval Ship Repair Facility (NAVSHIPREPFAC); U.S. Naval Supply Depot (NSD); U.S. Naval Air Station Cubi Point (NAS Cubi Point); U.S. Naval Regional Medical Center (NAVREGMEDCEN); and the U.S. Naval Magazine (NAVMAG). Location of these major commands is shown on Figure 2-1. All seven commands are solid waste generators. However, due to the similarity of wastes produced, only four major categories of solid waste need to be considered: housing wastes, hazardous wastes, special wastes, and industrial/commercial wastes.

HOUSING WASTES

There are 1,330 housing units for married personnel at the U.S. Facility Subic Bay (see Table 2-1). Twice weekly curbside collection is provided by commercial contract at each residence. Waste is also picked up at 38 public waste containers (normally adjacent to bus stops). The contractor is responsible for pickup, vehicle operation and maintenance, and off-base disposal (Ref 2). Since this residential solid waste does not enter the on-base solid waste stream disposed of at the sanitary landfill, it will not be discussed further.

HAZARDOUS WASTES

PWC Subic Bay is responsible for the management, collection, and disposal of hazardous materials generated at the U.S. Facility. PWC Subic Bay is implementing a three-phase Hazardous Waste Management

System as directed by PACNAVFACENGCOM (Ref 3). Presently, the following hazardous wastes are managed:

1. Asbestos wastes - packaged and buried in the sanitary landfill.

2. PCB's - packaged and stored by PWC Subic Bay.

3. Cyanide, mercury, and chromium plating wastes - separate treatment at NAVSHIPREPFAC with residue disposal by PWC Subic Bay.

4. Oils and solvents - reblended and burned in diesel power plants or used for fire fighting training.

Since hazardous wastes do not normally enter the local solid waste stream they will not be discussed further.

SPECIAL WASTES

For purposes of this report, special wastes are defined as those solid wastes which, although they may not be considered as hazardous wastes, receive special handling. Several wastes fall into this category at the U.S. Facility, including: cigarettes, magazines, spoiled meat and other foodstuffs, food wastes (clubs), and hospital wastes.

Cigarettes

Over-age cigarettes and tobacco products are routinely disposed of by the Navy Exchange. Currently these products are soaked with waste oil and burned at the landfill site. A witnessed destruction is required in order for the Navy Exchange to receive a return credit from their distributors. Destruction of the tobacco products is also performed to prevent creation of a valuable waste which might encourage unauthorized scavenging at the landfill.

Magazines

The Philippine government regards certain adult magazines which are sold at the Navy Exchange as illegal pornography. They are not available for purchase off-base. Accordingly, unsold adult magazines are segregated and destroyed in the same manner as over-age cigarettes.

Spoiled Meats and Other Foodstuffs

Because of the scavenger problem at the landfill, disposal of spoiled foodstuffs is of special concern. Such wastes are segregated at the landfill and destroyed by extra compaction with a bulldozer before normal landfilling. The object of this treatment is to render the spoiled foodstuffs undesirable to the scavengers and prevent them from showing up in the local blackmarket.

Foodwastes (Clubs)

Foodwastes from the clubs (Commissioned Officers Mess, Chief Petty Officers Mess, Enlisted Men's Club, and Marine Staff NCO Club) are separated and sold to an outside contractor for rendering. The quantities of foodwastes involved or what processing, if any, that these wastes receive after leaving the base is unknown.

Hospital Wastes

An incinerator is used to dispose of medically related wastes produced at NAVREGMEDCEN. Data on quantities of material processed and supplemental fuel costs were unavailable.

INDUSTRIAL/COMMERCIAL WASTES

Industrial/commercial wastes are defined as those wastes that are generated by the military and industrial activities at the U.S. Facility, Subic Bay. This definition excludes housing wastes, hazardous wastes, and special wastes which were previously discussed.

Industrial/commercial wastes are collected by PWC Subic Bay employees, manually sorted and inspected, recyclable materials recovered, and solid waste residues disposed of at the base sanitary landfill. Management of these wastes is described below in terms of the functional elements of solid waste management: waste generation, storage, collection, processing and recovery, and disposal (Ref 4).

Waste Generation

Industrial/commercial wastes are generated by all seven major commands at the U.S. Facility (see Figure 2-1). Sources of waste include:

1. NAVSTA - offices, barracks, food services, commercial wastes (Navy Exchange and commissary), and waste from moored ships.

2. PWC Subic Bay - construction and industrial wastes.

3. NAVSHIPREPFAC - industrial wastes and waste from moored ships.

4. NSD - packaging wastes.

5. NAS Cubi Point - offices, barracks, and waste from moored ships.

6. NAVREGMEDCEN - office and food service wastes.

7. NAVMAG - industrial wastes.

The composition and quantity of these wastes are discussed in Section 3 of the report.

Storage

Industrial/commercial wastes are stored near the generation site in a variety of containers (see Table 2-2). These containers are being gradually standardized as the on-base collection fleet is upgraded to front loading trucks. Containers are visually inspected at the recycling facility and repaired and cleaned as required.

Collection

The varied topography of the U.S. Facility makes collection of solid waste difficult. As shown in Figure 2-2, industrial/commercial waste is collected at each of the major commands and transported to the recycling facility, which is located in the northwest corner of the Naval Base. After the separation process, recyclable materials are either stored on-site for pickup by buyers or transported to the Defense Property Disposal Office (DPDO) yard near the Naval Supply Depot.

Processing and Recovery

All of the industrial/commercial wastes are transported to the recycling facility located near Gate 1 (see Figures 2-3 and 2-4). Waste is dumped on a concrete slab and manually separated into three general categories:

1. Recyclable materials - paper, cardboard, wood, aluminum cans, and plastic.

2. Scrap materials - brass, copper, iron, tires, aluminum, and wire.

3. Nonrecyclable residue - food wastes, packaging wastes and miscellaneous potentially recyclable materials that may be undersized or overlooked by sorters.

Recyclable materials are baled, stored on-site, and sold by competitive contracts by DPDO. Scrap materials are transported to the DPDO yard for storage and also sold through competitive contracts (Ref 5).

Nonrecyclable residue is transferred to the base sanitary landfill (Figure 2-3). The quantities recovered are developed in Section 3.

The actual manual sorting is performed by members of the New Cabalan Negritos Labor Association, a Philippine government-sponsored corporation (Ref 5). The Labor Association supplies between 45 to 57 laborers, 7 days/week to the recycling facility. The Labor Association is paid on a lump sum basis (Ref 6). Terms of the contract are negotiated yearly.

The contract with the Labor Association has a long history which is discussed in detail in Reference 5. Briefly, the Negritos were the original inhabitants of what is now part of the housing areas of the U.S. Facility. The Navy felt obligated to provide the Negritos with some form of livelihood to compensate them for relocation from their former hunting areas. It is command policy to honor this commitment.

Safety conditions at the Recycling Facility could be improved. Most of the Negrito contract workers observed on a recent site visit were not wearing Navy-supplied safety equipment (hard hats, gloves, or eye protection); trucks and cranes were working in the sorting area without spotters or supervisory personnel directing them; workers were climbing on a 20-foot high pile of unsorted waste while a crane was simultaneously loading materials from the same pile.

In addition to the Negrito laborers and PWC Subic Bay personnel involved in the sorting operation, security personnel from both the Naval Investigative Service (NIS) and PWC Security Division are present. The security agents look for classified material, contraband, and valuable government materials. The value of material recovered is substantial. For example, property worth over $130,000 was recovered during a 7-month period in 1982 (Ref 5). Items recovered ranged from a life preserver ($21) to a gyroscope ($18,680).

Disposal

Nonrecyclable material is hauled to the base sanitary landfill in rear loading compactor trailers. The present landfill site is located about 3,000 feet to the west of the Navy Exchange and Commissary complex (see Figure 2-3). It will also be about an equal distance north of the proposed site of the new NAVREGMEDCEN.

One continuing problem at the landfill site has been the infiltration of unauthorized scavengers. These intruders are recovering materials from the landfill before the daily cover is placed. On occasion they have also dug up and removed landfilled materials. Besides the obvious safety and health dangers of such a practice, the intruders are violating the physical security of the base. The problem is receiving attention at the highest levels of command.

Table 2-1. Housing Units at U.S. Facility, Subic Bay

Area	Units
Kalayaan Housing	385
Binictican Housing	386
Samahan Heights	270
Bayani Village	200
Naval Station Housing	30
NAS Cubi Point Housing	50
Naval Hospital Housing	9
Total	1,330

Table 2-2. Existing Solid Waste Containers (Ref 1)

Type	Number of Containers	Capacity of Each (yd^3)
Dynosor	55	20 30 40
Dyno Master front load	114	4 8
Dempster Dumpster	486	4 6 8 10 12

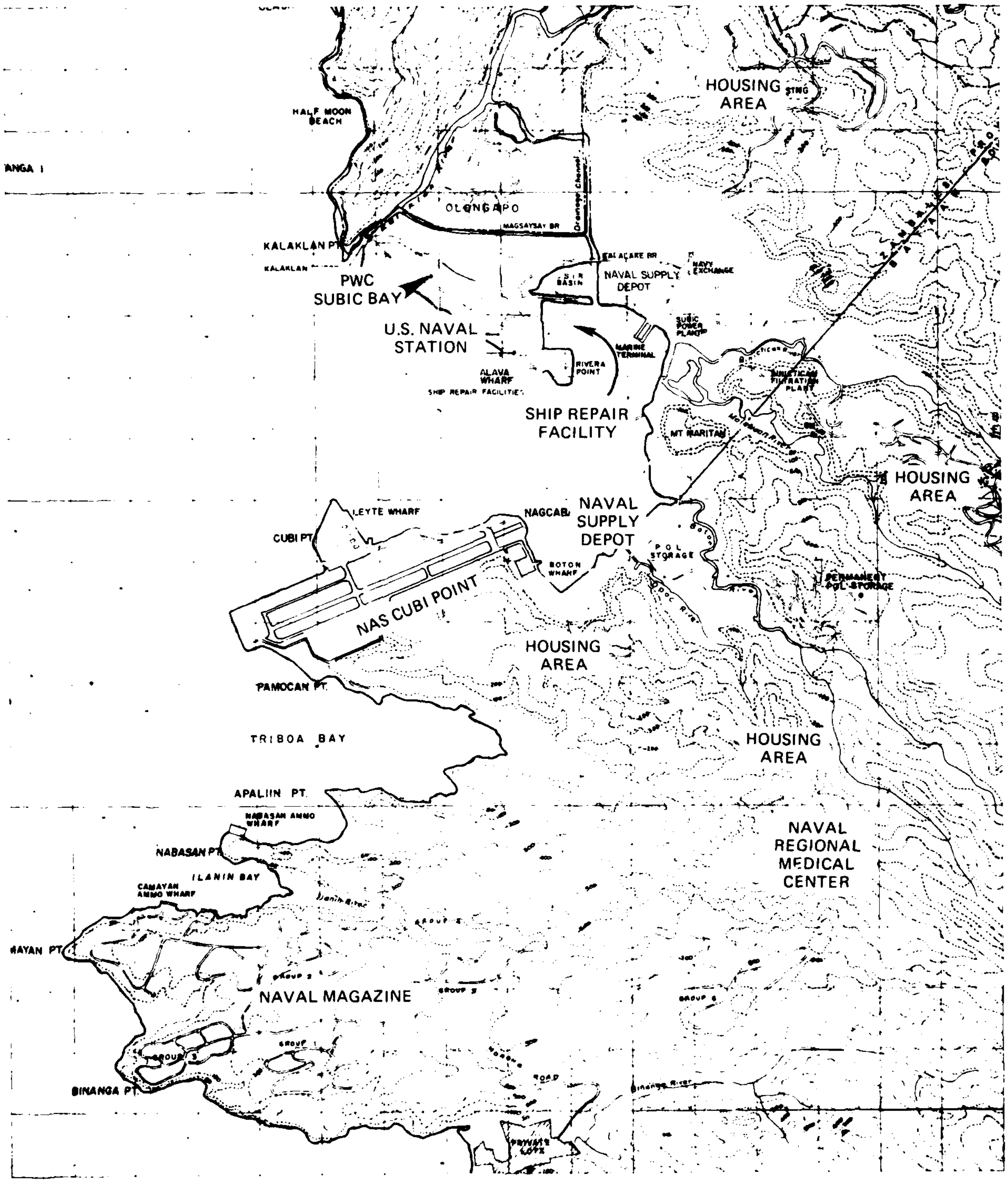


Figure 2-1. Major commands, U.S. Facility, Subic Bay.

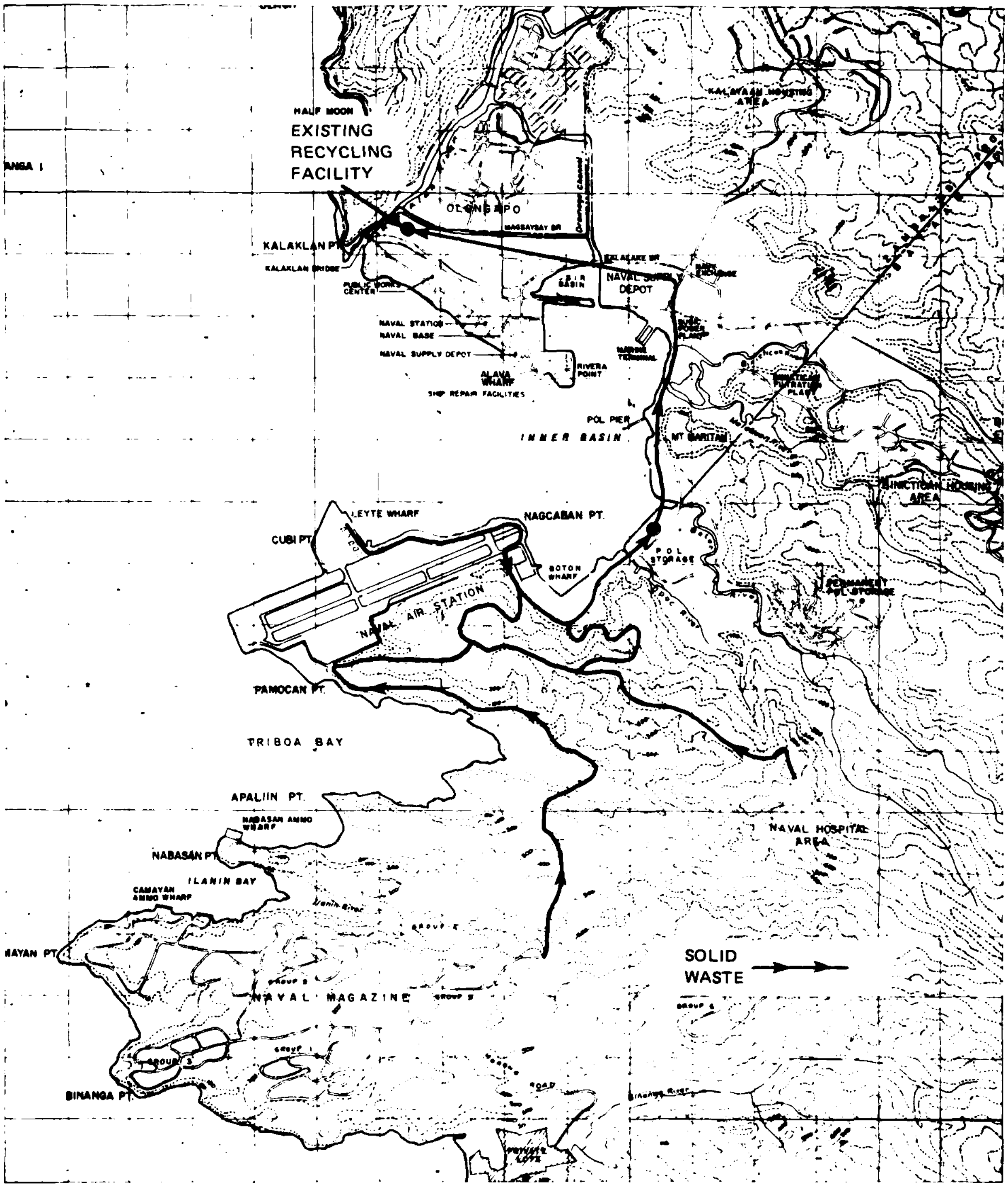


Figure 2-2. Solid waste collection routes.

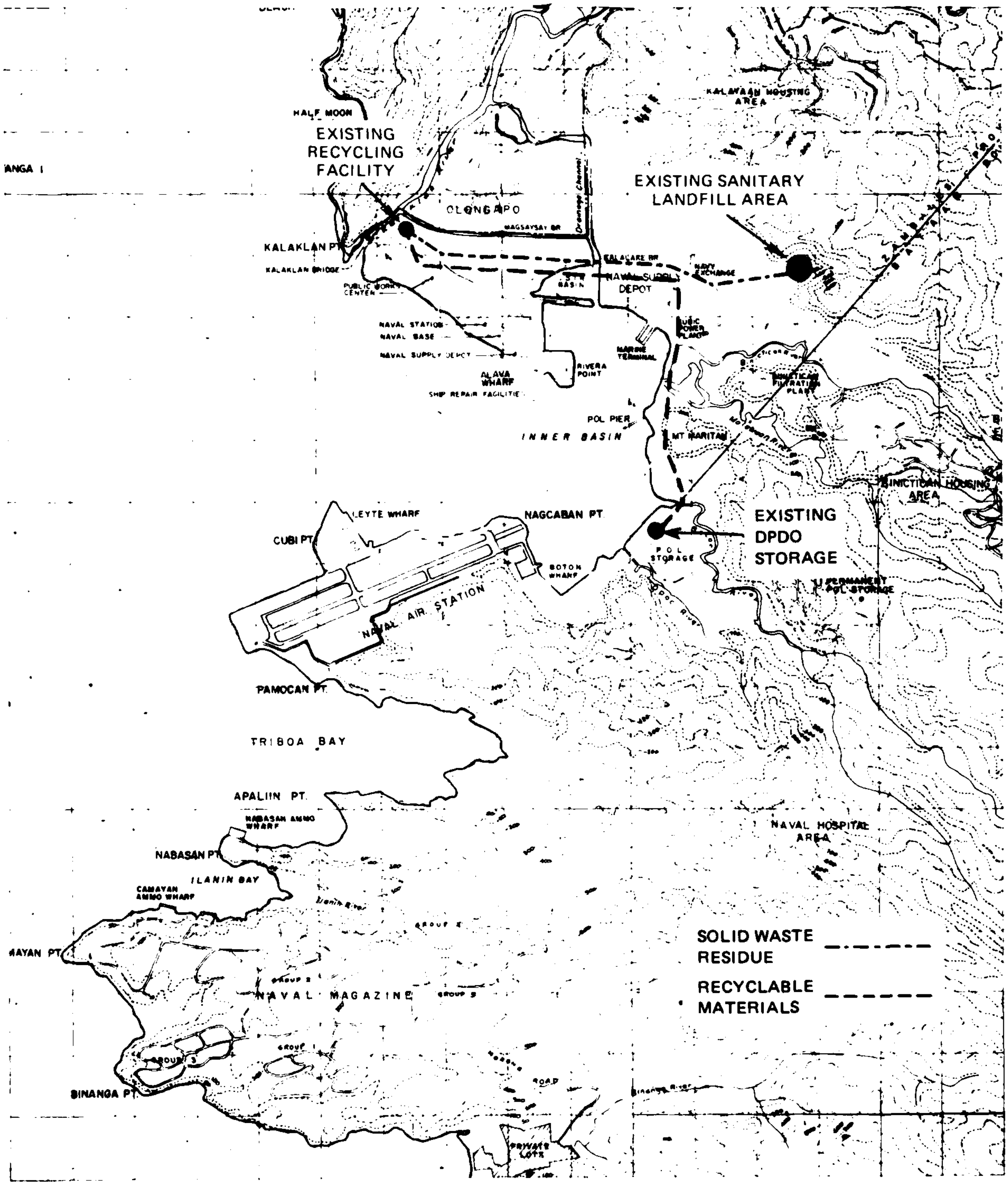


Figure 2-3. Solid waste processing facility and disposal site.

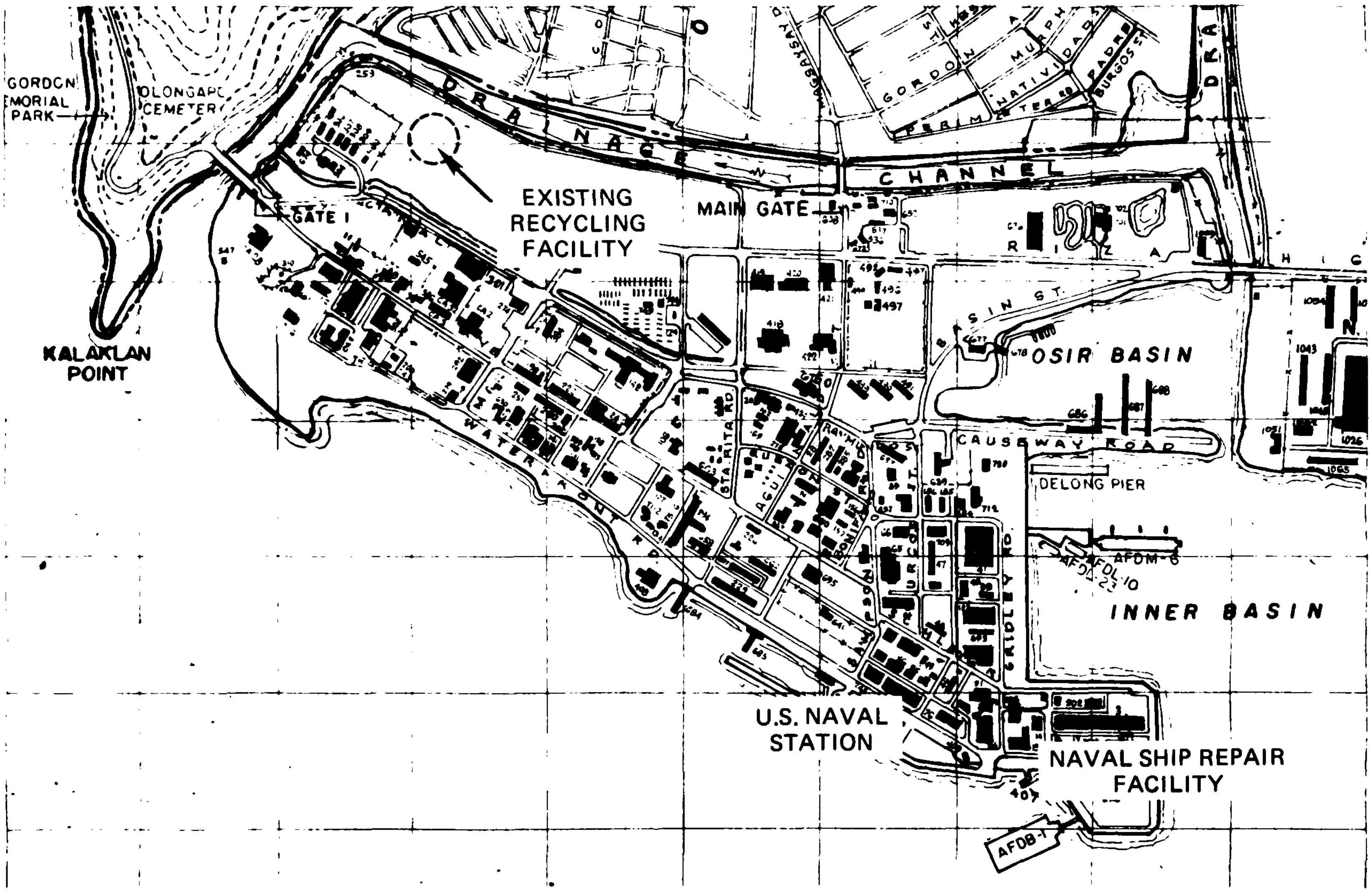


Figure 2-4. Existing recycling facility.

Section 3

SOLID WASTE QUANTITIES

As described in the previous section, industrial/commercial wastes are manually sorted and recycled by PWC Subic Bay prior to disposal at the base sanitary landfill. An accurate estimate of the quantity of wastes received at the recycling facility and disposed of at the landfill is essential for the planning and design of an improved system.

INCOMING WASTES

Industrial/commercial wastes are collected and delivered to the recycling facility 7 days a week, 365 days a year. Section 2 described waste generation and collection. The wastes received at the recycling facility are tallied on a "Daily Accomplishment Report Summary Sheet." Data for the 6 month period from April to September 1982 was provided by PWC Subic Bay (Ref 7) and is summarized in Table 3-1. From this somewhat incomplete record, daily and monthly averages of 815 yd^3/day and 24,801 yd^3/month and a yearly total (for 1982) of 297,612 yd^3/year were estimated. This is considerably less than the 26,000 m^3/month (408,096 yd^3/year) estimated in Reference 6, or the 829,032 yd^3/year estimated in Reference 1. A daily average of 1,559 yd^3/day was estimated by Mr. Ron Middleton, of PWC Subic Bay. This estimate is equivalent to 569,035 yd^3/yr.

MATERIALS RECOVERY

Once received at the recycling facility, incoming commercial/industrial wastes are hand sorted by Negrito contract workers into several categories as shown in Table 3-2. The most economically significant materials are nonferrous scrap metals (aluminum, brass, copper, and lead batteries), copper electrical wiring, cardboard, and wood. The 9-month record summarized in Table 3-2 can be extrapolated to about 5,148 tons of materials recycled in 1982.

SOLID WASTE RESIDUE

After separation and recovery of recyclable materials, the remaining solid waste residue is transported to the base sanitary landfill in a 60 yd^3 moving floor compactor trailer. Accurate weight and volume measurements of industrial/commercial waste delivered to the recycling

facility are not available. Even daily truck counts are not available, but PWC Subic Bay estimates that an average of five trips are made per day, for a total of 300 yd^3 of compacted solid waste residue per day (Ref 7). Density measurements made by PWC Subic Bay on 14 Jan 1984 show an average density of 281 lb/yd^3 for the compacted residue. Thus, an estimated 42 tons/day of residue is sent to the landfill for disposal. This is equivalent to 15,330 tons/yr.

MASS BALANCE

Without a longer term record and density measurements of both solid waste into the recycling facility as well as residue to the landfill, it is difficult to accurately calculate a mass balance around the recycling facility. However, detailed records are kept of recycled materials which are resold. Also, cne density measurement of landfill residue and a daily residue volume estimate are available. Thus, a mass balance can be calculated:

Solid Waste Delivered = Materials Recycled + Residue Landfilled

Solid Waste Delivered = 5,148 tons/yr + 15,330 tons/yr

Solid Waste Delivered = 20,478 tons/yr = 56 tons/day

As an additional check on the mass balance, an approximation of the density of the incoming solid waste can be made. Using the 1982 daily volume estimate of 815 yd^3/day results in a density of 137 lb/yd^3. If the 1983 daily volume estimate of 1,559 yd^3/day, and a proportional increase in recyclable materials is assumed, a new mass balance for 1983 can be calculated:

Solid Waste Delivered = 1,559 yd^3/day x 137 lb/yd^3/2,000 lb/ton

Solid Waste Delivered = 107 tons/day

Materials Recovered = 5,148 tons/yr x (1559/815)

Materials Recovered = 9,848 tons/yr = 27 tons/day

Residue Landfilled = 107 tons/day - 27 tons/day

Residue Landfilled = 80 tons/day = 29,200 tons/yr

CONCLUSIONS

Due to the lack of solid waste quantity data, only an estimated range of solid waste delivered to the recycling facility can be made: 408,000 to 569,000 yd^3/yr. The density of this material is about 137 lb/yd^3. Based on incomplete volume records and one set of density measurements, approximately 15,330 tons/yr (42 tons/day) to 29,200 tons/yr (80 tons/day) of solid waste residue are estimated buried at the base sanitary landfill.

Table 3-1. Industrial/Commercial Wastes Collected at the U.S. Facility, Subic Bay (Ref 7)

Month (1982)	Quantity (yd^3)
April	25,492
May	28,360[a]
June	28,498
July	23,306
August	21,448[a]
September	21,700[a]

[a]Extrapolated from partial data.

Table 3-2. Materials Recovered by PWC Subic Bay
(October 1982 through June 1983)

Material	Unit Value ($/metric ton)	Quantity[a] (metric tons)	% by Weight	Gross Income ($)	% of Total Income
Aluminum cans	323.81	15.10	0.4	4,890	1.5
Aluminum scrap	283.31	112.94	3.2	31,997	10.1
Automotive parts	46.91	36.77	1.0	1,725	0.5
Batteries	241.00	57.99	1.7	13,976	4.4
Brass	902.14	24.73	0.7	22,310	7.1
Cardboard	71.75	749.25	21.4	53,759	17.0
Copper	902.14	58.84	1.7	53,082	16.8
Electrical wire	846.56	53.42	1.5	45,223	14.3
Mixed metals	46.91	282.01	8.0	13,229	4.2
Mixed paper	129.40	47.71	1.4	6,174	2.0
Motors	46.91	3.27	0.1	153	<0.1
Plastic (baled)	61.23	67.94	1.9	4,160	1.3
Rubber (including tires)	40.44	154.05	4.4	6,230	2.0
Stainless steel	340.00	13.91	0.4	4,729	1.5
Steel	46.91	748.58	21.4	35,116	11.1
Wood	15.86[b]	1,078.51	30.8	19,460	6.2
Totals		3,505.02	100.0	316,212	100.0

[a]One metric ton = 1.1016 U.S. tons.

[b]Unit value was $23.49/metric ton through February 1983.

Section 4

STEAM AND ELECTRICAL SYSTEMS

PWC Subic Bay is responsible for supplying all utilities to the entire U.S. Facility, including steam and electricity. This section discusses existing steam and electrical generating capacity, examines steam and electrical demands, and reviews planned improvements to the system.

STEAM GENERATION CAPACITY

PWC Subic Bay currently operates over 30 boilers (Ref 8). The majority of these boilers are small, single-purpose, packaged units of 60 boiler horsepower (hp) or less. Specifications of these units are summarized in Table 4-1 in units of both boiler hp and pounds/hour of steam. Equivalent pounds/hour of steam were calculated by using the conversion factor 1 boiler hp equals 34.5 lb/hr of equivalent steam from and at 212°F. This is an outmoded factor based on the amount of steam required by a typical reciprocating steam engine to produce 1 hp/hr of mechanical energy (Ref 9). Boiler hp data were supplied by Reference 8.

Total capacity of the system is 3,735 boiler hp or 128,858 lb/hr of equivalent steam. Most of the capacity (2,960 boiler hp) is concentrated at relatively few locations (see Figure 4-1):

1. Building 49, NAVSHIPREPFAC (7 boilers, 1,820 boiler hp total).

2. Building 285, NAVSTA (5 boilers, 400 boiler hp total).

3. Building 8258, NAS (2 boilers, 340 boiler hp total).

4. Leyte Wharf, NAS (four mobile utility support equipment* boilers, 200 boiler hp total).

5. Boton Wharf, NAS (4 MUSE boilers, 200 boiler hp total).

The remainder of the capacity (775 boiler hp) is dispersed at 15 other locations with smaller boilers of 5.4 to 60 boiler hp each (see Table 4-1).

---

*Mobile Utility Support Equipment (MUSE).

STEAM DEMAND

Current steam demands of the users of the smaller single-purpose units are being met. Peak steam demands of the major steam consumers are summarized below:

1. NAVSHIPREPFAC Waterfront area (including shore to ship, floating drydocks, and NAVSHIPREPFAC industrial facilities): 49,100 lb/hr at 150 psi (1,500 boiler hp).

2. Leyte Wharf (CVAN 65/68 class aircraft carrier): 12,000 lb/hr at 150 psi (350 boiler hp).

3. Boton Wharf (CG and AD/AR class ships): 4,300 lb/hr at 150 psi (125 boiler hp).

Details on these steam loads can be found in Reference 8.

PLANNED STEAM SYSTEM IMPROVEMENTS

PWC Subic Bay has reviewed the present steam system and concluded that the small package steam units are adequate. However, the steam systems which serve the major consumers need improvements. The planned improvements are summarized in Reference 8. Briefly the major improvements include:

1. Modifications to the Building 49 boilers (MCON P-878). The main steam plant at Building 49 was built in 1949 and requires extensive improvements and repairs to improve reliability and improve efficiency.

2. Repairs to the distribution system (MCON P-879). The steam and condensate return systems in the NAVSTA and NAVSHIPREPFAC areas have excessive leakage and thus waste energy.

3. Installation of permanent boilers to replace the present temporary MUSE boilers at the Leyte and Boton Wharves (MCON P-788 and P-815). Permanent steam generation facilities are needed to meet the requirements of CVAN type aircraft carriers at Leyte Wharf and CG and AD/AR type ships at the Boton Wharf.

ELECTRICAL GENERATION CAPACITY

Electrical power for the Subic Bay-Cubi Point complex is provided by an interconnection of Navy-owned power stations and commercial power purchased from the Philippine government-owned National Power Corporation (NPC). Currently, PWC Subic Bay contracts for 36 MW from NPC.

PWC Subic Bay operates six power stations with a total capacity of 54 MW (Ref 8). Locations of the two principal power stations are shown on Figure 4-1. Each station is composed of a number of relatively small diesel generators ranging in size from 250 to 4,400 kW--a total of 39 separate diesel generators (see Table 4-2).

ELECTRICAL DEMAND AND CONSUMPTION

For the FY82-83 period the average daily demand for the Subic Bay-Cubi Point complex was 35 to 48 MW with a maximum daily peak of 53 MW (Ref 8). During the 18-month period from October 1981 to March 1983, monthly average consumption was 19,960 MWh with a monthly peak consumption of 25,650 MWh in January 1983 (see Table 4-3) (Ref 10). Power requirements in excess of the NPC contract are supplied by running PWC Subic Bay's power stations.

PLANNED ELECTRICAL SYSTEM IMPROVEMENTS

Although the presently installed generators operated by PWC Subic Bay can handle the current load, PWC Subic Bay estimates that peak demand will increase 13 MW by FY89. The power load at the U.S. Facility is a mixture of permanent loads from the shore facilities and temporary loads from berthed ships. Several of the ship berthing areas do not have sufficient power capacity to meet current demands:

1. Alava Wharf: inadequate 480-volt power; 50% deficiency at substation. For CVN 68 class aircraft carrier, 4,180-volt power unavailable.

2. Rivera Wharf: inadequate 480-volt power; 60% deficiency at substation.

3. Boton Wharf: no permanent substation (MUSE diesel generator installed).

Condition of Equipment

Permanently installed diesel generators range in age from 13 to 27 years old, while supplementary MUSE diesel generators range from 5 to 25 years old. PWC Subic Bay has an effective ongoing preventive maintenance program and has identified several major systems that need replacement (Ref 8).

1. Subic Power Plant: Permanent generators require normal overhaul. Replacement of old auxiliary equipment should keep the plant operational through the next 5 years.

2. Cubi Power Plant: Poor condition, units 1, 5, 6, 7, and 8 should be replaced within the next 5 years.

3. Hospital Standby Power Plant: Poor condition, units should be replaced within 5 years (can be coordinated with the new hospital complex, MILCON Project P-919).

90,000-kW Power Plant Project

PWC Subic Bay is developing a MILCON project (P950) to replace the existing Subic and Cubi power plants and their associated temporary MUSE generators with a new permanent facility. The proposed plant would contain multiple identical 5,000-kW diesel generators with a total capacity of 90 MW. Such a facility would improve system reliability, allow removal of inefficient MUSE generators, and enhance operation of the U.S. Facility. (The MILCON submission was not finalized at the time this report was written).

Table 4-1. Boiler Plants Operated by PWC Subic Bay

Building Number	Location	Boiler Number	Manufacturer	Year Manufactured	Boiler (hp)	Equivalent lb/hr Steam[a]
CA-2	PWC Food Services	53P25	Ames Iron Works	1944	60	2,070
		60P71	Orr & Sembower	1952	13	449
8579	MAU Camp	56P36	Preferred Utilities	1943	60	2,070
58	NAVSTA	56P29	Aldrich		5.4	186
8348	NAS NX Laundry	56P39	Cleaver Brooks	1951	60	2,070
		70P110	Rockmills Steel Products	1969	26	897
285	NAVSTA EM	57P46	Munds Boiler	1957	80	2,760
	Messhall/NX Laundry	57P48	Munds Boiler	1957	80	2,760
		57P49	Munds Boiler	1957	80	2,760
		60P73	Cyclotherm	1952	80	2,760
		60P75	Cyclotherm	1952	80	2,760
8045	NAS C Hangar	56P46	Munds Boiler	1955	50	1,725
408	Subic Officer's Club	59P59	Munds Boiler	1958	10	345
	Landfill	60P74	Cyclotherm	1952	80	2,760
664		61P81	Cyclotherm	1951	50	1,725
	Camp Santa Rita	65P91	Munds Boiler	1955	100	3,450
	Leyte Wharf		MUSE (4)	1973	200	6,900
	Boton Wharf		MUSE (4)	1973	200	6,900
49	NAVSHIPREPFAC (Base plant)	63P82	Cyclotherm	1952	80	2,760
		63P83	Cyclotherm	1952	80	2,760
		63P84	Cyclotherm	1952	80	2,760
		63P85	Cyclotherm	1952	80	2,760
		68P98	Kewanee	1966	500	17,250
		71P111	Superior Boiler	1968	500	17,250
		74P116	Cleaver Brooks	1973	500	17,250

Continued

Table 4-1. Continued

Building Number	Location	Boiler Number	Manufacturer	Year Manufactured	Boiler (hp)	Equivalent lb/hr Steam[a]
7341	San Miguel	68P105	S.T. Johnson Co.		10	345
8258	Asphalt Plant	70P109	Continental	1956	170	5,865
	NAS Central Steam Plant	73P113	Continental	1957	170	5,865
		73P114	Continental	1956	170	5,865
485	Theater	56P30	Aldrich		15	518
67	Laundromat	75P118	S.T. Johnson Co.	1953	6	207
8318	NAS BEQ	75P119	Orr & Sembower	1973	20	690
		75P121	Orr & Sembower	1973	20	690
8314	NAS BEQ	75P122	Orr & Sembower	1973	20	690

[a]Equivalent lb/hr steam = boiler hp x 34.5.

Table 4-2. Electrical Generating Plants Operated by PWC Subic Bay

Unit No.	Manufacturer	Electricity Output	
		Name Plate (kW)	Normal (kW)
Subic Main Plant			
1	Nordberg	4,400	3,850
2	Nordberg	4,400	3,850
3	Nordberg	4,400	3,850
4	Nordberg	4,400	3,850
5	Nordberg	4,400	4,000
6	Nordberg	4,400	4,000
	Subtotal	26,400	23,400
Subic Peaking Plant			
1	GM-EMD	2,000	1,800
2	GM-EMD	2,000	1,800
3	GM-EMD	2,000	1,800
4	GM-EMD	2,000	1,800
5	GM-EMD	2,000	1,800
6	GM-EMD	2,000	1,800
7	GM-EMD	1,500	1,400
8	GM-EMD	2,500	2,500
9	GM-EMD	2,500	2,500
10	GM-EMD	1,500	1,400
11	GM-EMD	1,500	1,400
12	GM-EMD	1,500	1,400
13	GM-EMD	1,500	1,400
14	GM-EMD	1,500	1,400
	Subtotal	26,000	24,200
Cubi Main Plant			
1	Worthington	520	400
2	Worthington	520	520
3	Worthington	1,000	800
4	Worthington	1,000	600
5	Worthington	600	500
	Subtotal	3,640	2,820

Continued

Table 4-2. Continued

Unit No.	Manufacturer	Electricity Output	
		Name Plate (kW)	Normal (kW)
Cubi Peaking Plant			
6	GM-EMD	1,000	800
7	GM-EMD	1,000	800
8	Enterprise	1,000	800
9	GM-EMD	1,500	1,400
10	GM-EMD	2,500	2,500
11	GM-EMD	2,500	2,500
12	GM-EMD	1,500	1,400
13	GM-EMD	1,500	1,400
	Subtotal	12,500	11,600
	Subic-Cubi Power Plant Total Capacity	68,540	62,020
Hospital Stand-by Units			
1	Enterprise	500	400
2	English-Electric	300	250
3	Chicago-Pneumatic	300	250
	Subtotal	1,100	900
Grande Island Power Plant			
1	Fairbank-Morse	96	86
2	Fairbank-Morse	249	225
2	Fairbank-Morse	249	225
	Subtotal	594	536
	Grand Total	70,234	63,456

Table 4-3. Subic-Cubi Monthly Power Consumption Summary (Ref 10)

Month/Yr	MWh
Oct 81	20,540
Nov 81	17,570
Dec 81	21,190
Jan 82	19,810
Feb 82	16,490
Mar 82	19,940
Apr 82	23,170
May 82	20,100
Jun 82	25,550
Jul 82	18,040
Aug 82	17,670
Sep 82	19,370
Oct 82	20,160
Nov 82	19,250
Dec 82	18,790
Jan 83	25,650
Feb 83	17,860
Mar 83	18,180
Total	359,330
Average monthly	19,960
Peak monthly	25,650

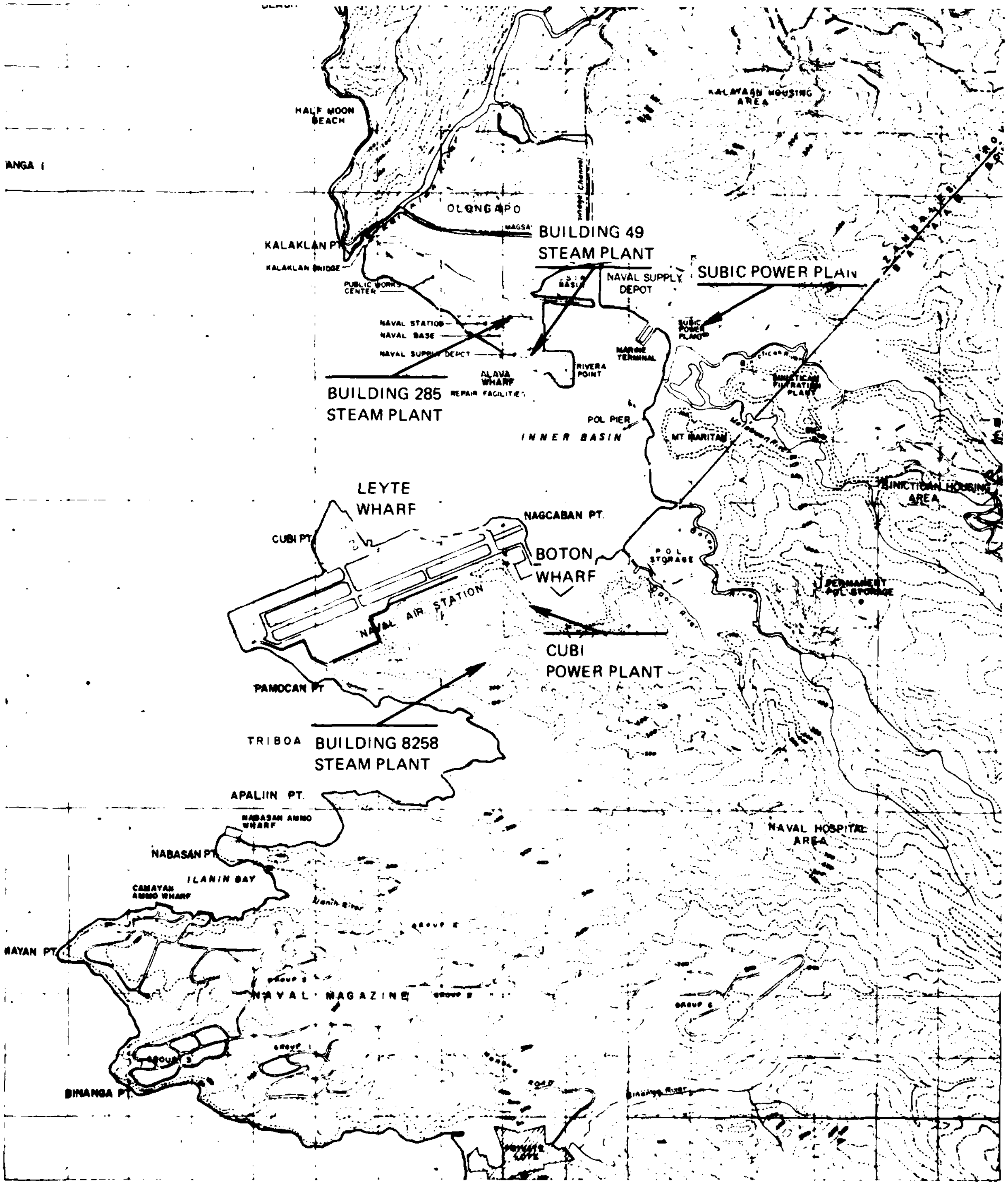


Figure 4-1. Existing steam and power plants.

Section 5

ALTERNATIVE RECYCLING AND RESOURCE RECOVERY SYSTEMS

This section discusses several alternatives for improving and enhancing the present industrial/commercial waste disposal system at the U.S. Facility Subic Bay. The systems to be considered will all meet the following objectives as previously discussed in SECTION 1 of this report:

1. Enhance physical security of the base.

2. Safeguard the employment rights of the Negrito workers.

3. Improve the habitability and cleanliness of the base.

4. Increase net revenues to PWC Subic Bay.

The alternatives can be implemented in phases since each is a refinement of the previous alternative.

ALTERNATIVE 1 - IMPROVEMENT OF THE EXISTING RECYCLING FACILITY

During an on-site visit by D. Brunner and S.A. Vigil of NCEL to the existing Recycling Facility in June 1983, several deficiencies were noted which could be corrected at minimal cost:

1. Improve equipment availability - on the day that the Recycling Facility was visited, the front end loader used for spreading and moving solid waste was down due to a blown tire. This significantly decreased worker productivity because they could only sort from the top layer of solid waste. Backup equipment and spare parts should be made available to the Recycling Facility from existing PWC Subic Bay resources.

2. Improve site layout and space utilization - due to poor layout of storage areas, the sorting area is overcrowded, preventing solid waste from being spread out in a thinner layer for more effective and easier sorting. Recovered materials should be removed from the sorting area as soon as possible. Site drainage should be improved to prevent standing water.

The cost to implement these changes would be minor.

ALTERNATIVE 2 - IMPLEMENTATION OF THE PLANNED RECYCLING FACILITY

PWC Subic Bay has recognized the shortcomings of the existing Recycling Facility and has prepared a MILCON project submittal for a new Recycling Facility (Ref 11). The proposed facility would be located along Argonaut Highway, between the Subic Power Plant and the POL Pier (see Figure 5-1). Key features of the proposed Recycling Facility include a paved 250- by 250-foot recycling yard (62,500 ft^2), a 40- by 50-foot covered sorting shed (2,000 ft^2), a 15-foot high earth berm to shield the site from public view, and steel cyclone fences for physical security. PWC Subic Bay estimated the cost of the new facility at $1,650,000 (Ref 11).

Implementation of the new Recycling Facility would be a great improvement over the existing one but it would still have several significant shortcomings, including the lack of a large enough covered sorting area. Such an area is needed to reduce polluting runoff and odors during the rainy season.

ALTERNATIVE 3 - SEMI-MECHANIZED RECYCLING FACILITY

A wide variety of systems have been proposed for resource recovery from solid wastes. Most of these systems have been designed to minimize manual labor and thus employ sophisticated technology, including shredders, flail mills, and air classifiers. Some of these systems have suffered from high capital and operating costs.

One of the objectives of this study is to recommend alternatives which would enhance resource recovery operations and preserve the employment rights of the Negrito contract employees. Thus, a less capital-intensive, but still labor-intensive semi-mechanized Recycling Facility, can be designed. Such a facility could employ partial mechanization to effect a separation and distribution of wastes using a low cost trommel screen and simple belt conveyors to improve worker productivity and safety. Capital and energy-intensive size-reduction equipment (i.e., shredders) would not be required. A flowsheet and conceptual sketch of such a facility are shown in Figure 5-2.

The facility will be housed in a covered, wall-less structure approximately 130 by 75 feet (9,750 ft^2). Solid waste will flow through the facility from left to right on conveyor belts. Wastes will be loaded onto the feed conveyor with a skip loader. Oversized metal wastes which might damage the feed conveyor will be manually removed.

A two-stage trommel screen with 6- and 18-inch holes will be the primary separation device. Disk screens will be used as secondary separators. A 6-inch disk screen will be used to remove undersized material from the minus 18-inch trommel fraction. An optional 1-inch disk screen will be used to remove grit (i.e. sand, broken glass) from the residue stream in the event that an incinerator is used for residue processing. Simple magnetic separators will be used on each trommel underflow line to separate iron.

Workers at stations along the underflow conveyors will manually remove recyclable materials such as aluminum cans and nonferrous metals and load them into adjacent transportable bins. Nonrecyclable residues will roll off the ends of the side conveyors into residue containers.

Oversized materials (>18 inches in diameter) will flow through the trommel screen to the discharge conveyor for oversized material where additional recyclable materials can be recovered. Oversized materials that will pass through the trommel screen include cardboard, wood pallets, tires, and large plastic sheets.

The semi-mechanized Recycling Facility will enhance worker productivity and safety because individual workers will not have to lift or carry materials great distances. The conveyors will also spread out the waste into a thinner layer than is now possible with the existing manual system. This will enhance the percentage recovery of recyclable materials. Based on a visual inspection of the residue in June 1983, recyclable materials recovery could well be doubled.

Key to the efficient operation of the facility is the rapid removal of both recyclable materials and residues. Recovered materials will be placed into bins at each worker station. This will allow for easy replacement of the bins as they fill up. Either forklift or manually rolled bins can be used, depending on the density and quantity of the materials anticipated at each removal point. Solid waste residues will be directly loaded from the conveyor into the compactor trailer for direct haul to the sanitary landfill, eliminating the existing crane operation.

ALTERNATIVE 4 - SEMI-MECHANIZED RECYCLING FACILITY WITH BALING

The semi-mechanized system described in the previous section should enhance recovery of recyclable materials. However, some residues will still require landfilling. Baling of these residues is a technique that can be used to make them undesirable to scavengers and reduce the volume of landfilled materials. In-place density increases of up to 60% have been obtained at operating bale fills. Normally the process involves shredding of the residues prior to baling. Since a considerable size separation will have already taken place in the Recycling Facility, shredding will be unnecessary. Since baling equipment is already being used to process cardboard, plastic, and aluminum cans, retraining of the Negrito contract workers will be not be required.

ALTERNATIVE 5 - SEMI-MECHANIZED RECYCLING FACILITY WITH INCINERATION

Incineration (without energy recovery) can be used as an add-on process to Alternative 3. Incineration can reduce the volume of solid waste residue to be buried by up to 90%. It would also render the residue totally useless and thus eliminate the incentive for intruders to enter the base landfill. An additional benefit of incineration is that special wastes such as cigarettes, magazines, and spoiled food can also be destroyed.

Processing by the Recycling Facility to remove metals, grit and noncombustibles should produce a fairly uniform, combustible solid waste residue composed almost entirely of organic materials and nonrecyclable paper. The combustibility of such material under rainy season conditions is unknown and would have to be determined prior to the implementation of such a process. Some type of auxiliary fuel is required when the waste is particularly wet.

ALTERNATIVE 6 - SEMI-MECHANIZED RECYCLING FACILITY WITH A HEAT RECOVERY INCINERATOR

Energy can be recovered from the solid waste residue with a heat recovery incinerator (HRI). Several types of HRI's are available, including excess-air and starved-air incinerators. In the former, the waste is burned on a moving grate, and energy is recovered by waste heat boilers or by water tubes or waterwalls in the combustion chamber. On the other hand, the starved-air incinerators incorporate multiple-stage combustion and waste heat boilers. Starved-air incinerators operate at relatively low temperatures and low turbulence in their primary combustion chamber. This results in lower particulate and oxides of nitrogen emissions compared to excess-air incinerators. In some cases, no additional air emission control devices are required.

Manufacturers

NCEL has identified over 40 starved-air HRI installations in the 20 to 120 ton/day range (Ref 12). The units are usually modular, factory-fabricated and field-assembled. Several United States manufacturers for this equipment exist including Consumat, Basic Environmental Systems, Kelley, and Environmental Control Products.

Energy Recovery Potential

Data from operating systems in Collegeville, Minn., (Basic Environmental Systems HRI-rated at 60 tons/day) (Ref 13) and Portsmouth, N.H. (Consumat HRI-rated at 200 tons/day) (Ref 14) show that a steam rate of 3 lb steam/lb of solid waste is attainable (saturated steam, 385°F, 200 psig, enthalpy = 1,200 Btu/lb steam). However, since a good portion of the combustible material would already have been removed in the PWC Subic Bay operation, a more conservative steam rate of 2 lb steam/lb of solid waste will be used. Assuming an equipment availability factor of 85%, 5,900 to 11,300 lb steam/hr should be recoverable from the 42 to 80 tons/day of solid waste residue presently landfilled (Section 3). With the current PWC Subic Bay rate of $13.00/million Btu, the energy recovered would be worth $813,000 to $1,545,000/yr. This is a gross estimate which does not take into account the actual composition and Btu value of the residue since these data were not available).

Steam Utilization

A review of Section 4 shows that three major steam consumers exist on the base:

1. NAVSHIPREPFAC Waterfront Area - 49,100 lb/hr

2. Leyte Wharf - 12,000 lb/hr

3. Boton Wharf - 4,300 lb/hr

Of these major steam consumers, the Boton Wharf and NAVSHIPREPFAC waterfront areas are the closest together. It may prove feasible to locate the HRI near one of these steam consumers and transport the residue to the HRI. This would reduce the length of the required steam lines.

Electricity Generation

Although it is possible to generate electricity from the steam, it is not economically feasible due to the small size of the system.

Hospital HRI

Consideration should be given to incorporating a smaller HRI into the design of the new NAVREGMEDCEN. The HRI could serve as both the required medical wastes incinerator as well as an industrial/commercial waste incinerator serving the NAVREGMEDCEN and possibly the adjoining Navy Exchange and commissary. The HRI could supply a portion of the steam load at the NAVREGMEDCEN. This is common practice at many larger medical facilities in the United States.

Another possibility is the use of steam generated by the Recycling Facility HRI to provide hot water and air conditioning for the new NAVREGMEDCEN. This could be accomplished by use of absorption chillers or by steam-turbine-driven rotary compressors. If the NAVREGMEDCEN is to be the principal steam consumer, it may be more efficient to locate the HRI adjacent to the NAVREGMEDCEN.

ALTERNATIVE 7 - LANDFILL GAS

The extraction of landfill gas from sanitary landfills is a proven technology. Basically, it involves extraction of biologically generated landfill gas with relatively simple wells and pumping systems. Landfill gas is composed of approximately 50% methane and 50% carbon dioxide. It thus only has about 50% of the energy value of natural gas which is almost 100% methane (landfill gas = 500 Btu/ft^3; methane = 1,000 Btu/ft^2). After cleaning the gas to remove excess moisture and trace amounts of hydrogen sulfide, the cleaned gas can then be burned in boilers to generate steam or to fuel spark ignition engines or gas turbined for electricity generation.

Existing landfill gas projects in the United States have been associated with relatively large landfills. Usually 1 million tons of waste in place at a filling rate of 1,000 tons/day of solid waste is considered to be the minimum economic size. Since the base landfill is being filled at a rate of only 40 to 80 tons/day and organic food wastes have been excluded from the landfill in recent years, the potential for landfill gas development at the Subic Bay landfill is low. However, paper is degradable into methane, although at a slower rate than food wastes. The tropical climate and high rainfall of the Philippines would probably accelerate the decomposition rate of the paper. Since there is no operating experience with landfill gas systems in tropical climates, the benefit of this effect is unknown. Implementation of Alternatives 4 through 6 would eliminate the landfill gas option.

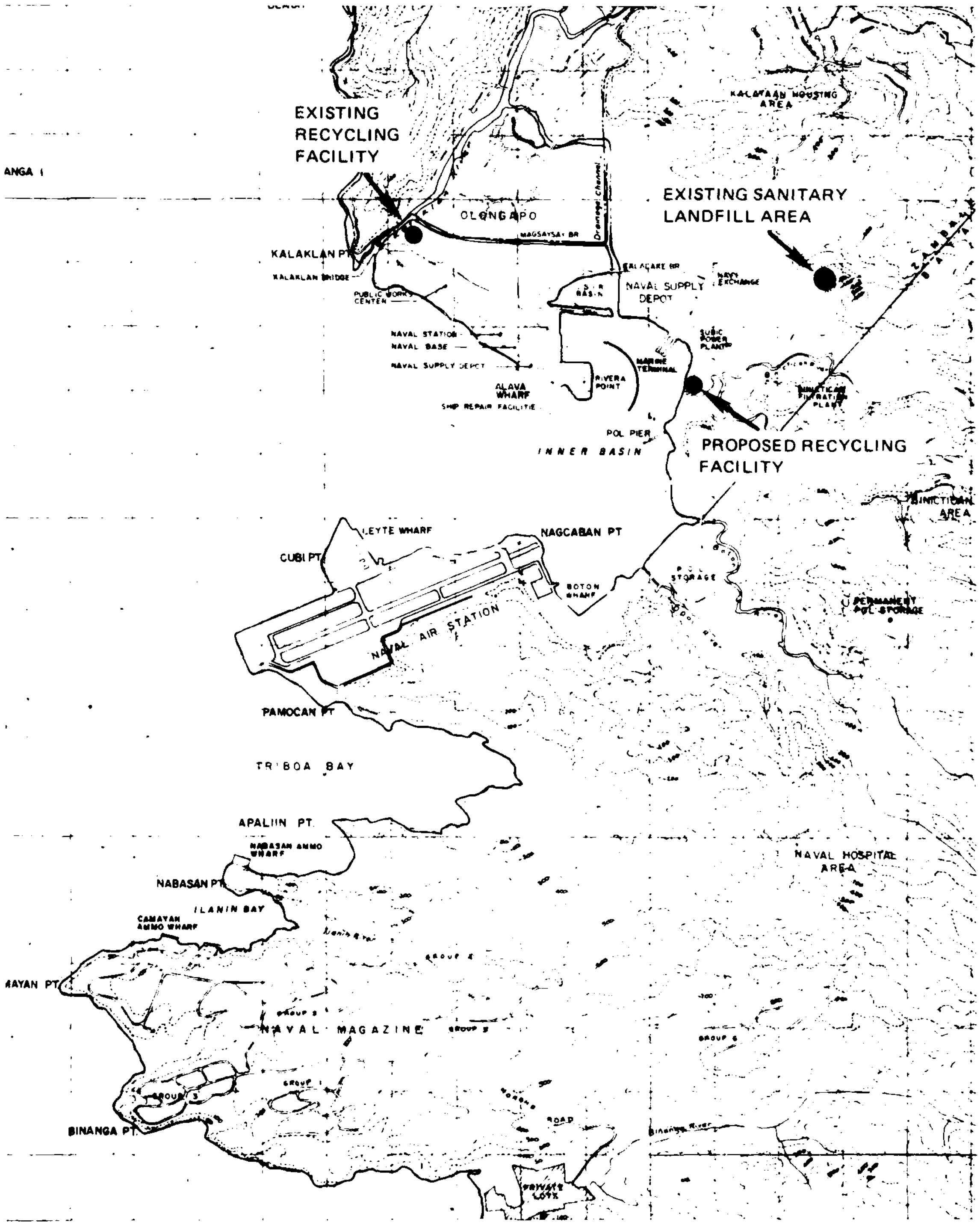


Figure 5-1. Proposed recycling facility (P-899).

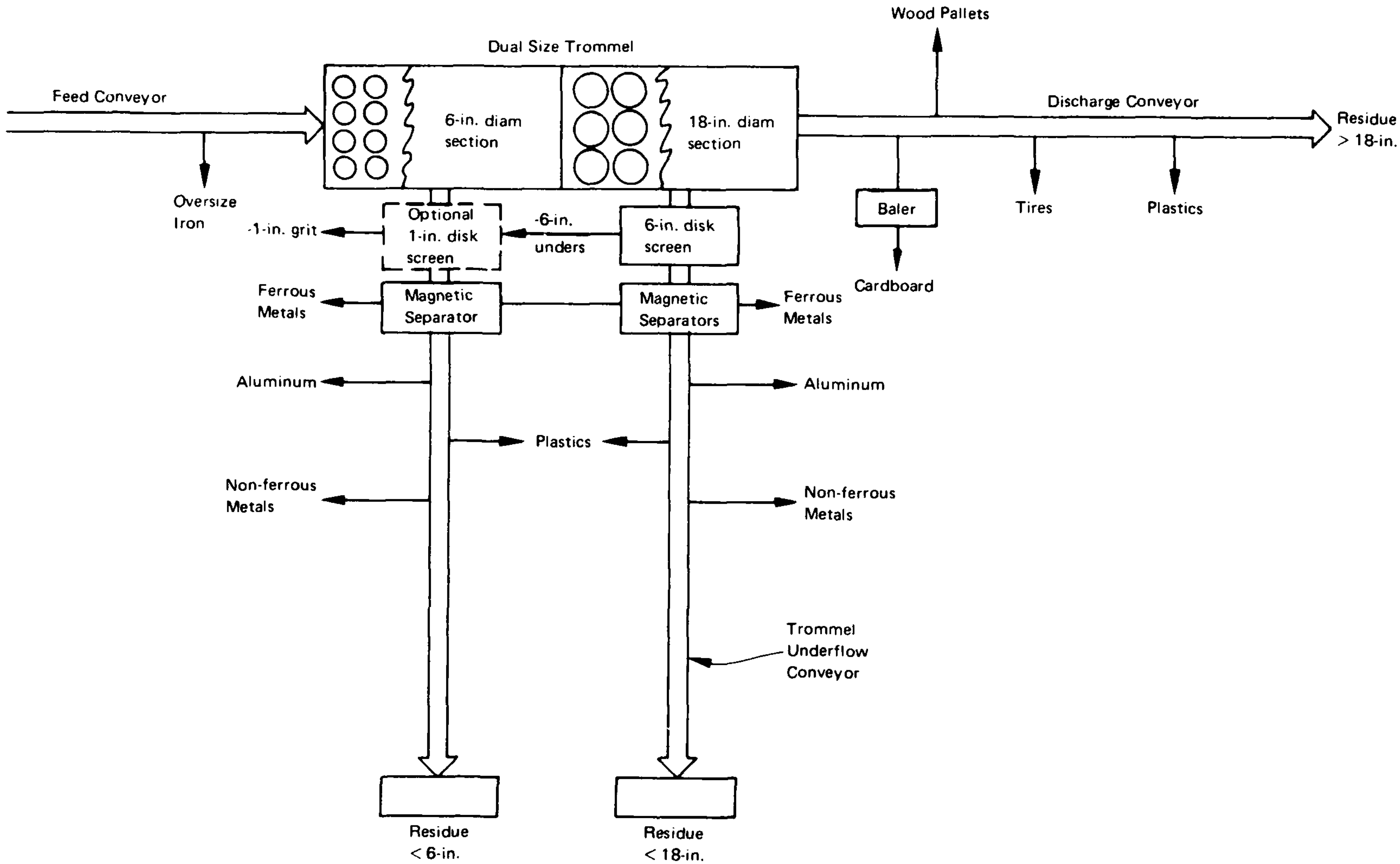


Figure 5-2. Flowsheet, semi-mechanized recycling facility.

Section 6

CAPITAL AND OPERATING COST COMPARISON

Seven alternatives to existing solid waste management practices were proposed in SECTION 5. Cost estimates of these alternatives will be presented in this section. Since a preliminary design has not been done, these cost estimates are based on published cost estimates of similar facilities in the United States. The cost estimates should be used for relative cost ranking only.

Since the present solid waste sorting contract will be continued in all seven options, the annual cost of this contract is a constant included in all alternatives. The cost of the sorting contract was 1,029,539 Philippine pesos for the 1982-1983 period (about $85,795 at the June 1983 exchange rate of 12 pesos = $1.00).

Whenever possible, costs have been adjusted to reflect the March 15, 1984 Engineering News Record Construction Cost Index of 4118. It is recognized that the unique labor and materials costs which exist in the Philippines may make such a cost adjustment index inappropriate. Therefore, caution must be used in applying these cost estimates. Recommendations for using locally fabricated materials will be made when appropriate, since use of these materials could substantially reduce costs.

ALTERNATIVE 1 - IMPROVEMENT OF THE EXISTING RECYCLING FACILITY

This alternative has essentially no additional capital costs or operating expenses above the existing facility. The existing operating expense of $85,795 for the sorting contract would continue.

ALTERNATIVE 2 - IMPLEMENTATION OF THE PLANNED RECYCLING FACILITY

The PWC Subic Bay staff estimated the capital cost of this new facility at $1,650,000 in 1981 (Ref 11). Since construction was originally planned to commence in February 1984, the capital costs have not been adjusted. Operating costs of this new facility are expected to be the same as Alternative 1.

ALTERNATIVE 3 - SEMI-MECHANIZED RECYCLING FACILITY

Alternative 3 consists of the improved recycling facility of Alternative 2 with the addition of a semi-mechanized separation system.

Capital Costs

The semi-mechanized recycling facility was assumed to utilize the same site as Alternative 2; thus these site development costs have been included. Major components of Alternative 3 include a prefabricated metal equipment shelter, a concrete paved sorting area, and the sorting equipment.

The prefabricated equipment shelter is an enlargement of the one proposed by PWC Subic Bay in Alternative 2. The open-sided structure was enlarged from 40 by 50 feet (2,000 ft^2) of the original design to 75 by 130 feet (9,750 ft^2). The concrete paving is essentially the same as Alternative 2, so no additional costs were estimated.

Table 6-1 summarizes the cost estimate for the new equipment, a total of $700,000. This estimate is based on actual price quotes for similar equipment for a waste to energy system for Santa Monica, California (Ref 15). The prices reflect cost quotes from U.S. manufacturers for June 1980, adjusted to March 1984.

It should be noted that much of this equipment is relatively simple and could be fabricated and procured in the Philippines, particularly the conveyors. The trommel screen is a custom-made device which could be designed by NCEL and fabricated in the Philippines. The disk screens and magnetic separators represent the only critical components which should be procured from United States sources. The need for these components depends on whether one of the incineration alternatives is selected.

Table 6-2 summarizes the capital costs of $2,426,000 for the entire facility. Note that the cost of Alternative 2 is included, and that equipment costs represent all United States made equipment. Thus, substantial cost savings could result from the use of locally procured components.

Operating Expenses

Table 6-3 summarizes operating expenses for Alternative 3. It was assumed that the present Negrito contract employees would continue to operate the new system, thus the cost of the present sorting contract is included. Other operating expenses include electricity and maintenance. Total operating costs are estimated to be $165,000/yr.

ALTERNATIVE 4 - SEMI-MECHANIZED RECYCLING FACILITY WITH BALING

Alternative 4 includes the semi-mechanized recycling facility of Alternative 3 and a baling system to densify nonrecyclable solid waste residues.

Capital Costs

Table 6-4 summarizes capital costs for Alternative 4. Base costs of the system are the same as Alternative 3. An additional cost of $220,000 is required for a 100 ton/day rated solid waste baler. Such equipment is similar to the smaller balers presently being used at the recycling facility for baling cardboard, aluminum cans, and plastic.

Operating Expenses

Table 6-5 summarizes operating costs for the system. Labor costs are based on the assumption that the existing Negrito contract employees can be trained to operate the new baler, thus no additional employees will be required. Other operating expenses include maintenance, electricity, and baling wire.

ALTERNATIVE 5 - SEMI-MECHANIZED RECYCLING FACILITY WITH INCINERATOR

Alternative 5 consists of the semi-mechanized recycling facility of Alternative 3 with incineration of the nonrecyclable residues.

Capital Costs

Base costs of the system include the semi-mechanized recycling facility of Alternative 3 plus the incinerator and support equipment. Table 6-6 summarizes the costs of this equipment. Capital costs are based on the actual cost of similarly sized equipment at Ft. Leonard Wood and Ft. Eustis (Ref 16). Major components include scales, incinerator, residue handling system, installation costs, incinerator building, and site preparation.

Operating Expenses

Table 6-7 summarizes the operating expenses for the facility. Base costs are the same as Alternative 3 and include the sorting contract, electricity, and maintenance. Additional expenses attributable to the incinerator include maintenance, electricity, supplementary fuel oil which may be required, and additional skilled labor. The last two items are not priced since their cost depends on local conditions. Waste oil has been used as a source of auxiliary fuel at many installations. However, it should be noted that many incinerators, especially those operating on the excess-air concept and burning wastes similar to those at Subic Bay, do not require auxiliary fuel.

ALTERNATIVE 6 - SEMI-MECHANIZED RECYCLING FACILITY WITH A HEAT RECOVERY INCINERATOR

Alternative 6 is essentially the same as Alternative 5 with the addition of a heat recovery incinerator for the production of steam.

Capital Costs

Table 6-8 summarizes capital costs for the facility. They are essentially the same as Alternative 5 except for the addition of a heat recovery boiler.

Operating Expenses

Operating expenses for Alternative 6 are assumed to be the same as Alternative 5, refer to Table 6-7.

ALTERNATIVE 7 - LANDFILL GAS

Since the landfill at Subic Bay is relatively small compared to existing commercially developed landfills, a detailed cost estimate for this alternative is not provided, rather capital cost and operating expense elements will be discussed.

Capital Costs

All landfill gas systems have several cost elements in common. These elements include:

1. Gas wells
2. Gas piping
3. Gas pump
4. Gas cleanup equipment
5. Gas distribution system

Other equipment, depending on the end use of the gas, can include:

1. Modified spark ignition engine
2. Electrical generator
3. Modified gas burners (if boilers are used)
4. Gas metering equipment

Because most landfill gas systems in the United States have been commercially developed under royalty contracts, cost estimates have not been publicly released. Cost estimates would therefore have to be developed during a preliminary design.

Operating Expenses

Typical operating expense elements for landfill gas systems include routine maintenance of the gas wells and pipelines, adjustment of valves and gas pumps to account for varying gas pressure, and maintenance of gas cleaning equipment. End use equipment such as the gas engine/generator set and gas burner will also require periodic maintenance.

COST SUMMARY

Table 6-9 summarizes capital and operating costs for Alternatives 1 through 6. Costs and expenses should be compared with care since they do not reflect possible cost savings from local manufacture of components nor do they show estimated revenues. Section 7 will discuss the net economic return of the alternatives.

Table 6-1. Equipment Costs - Alternative 3

Description	Cost Estimate[a] ($)
Trommel feed conveyor 8- x 50-ft (metal belt)	96,000
Trommel discharge conveyor 8- x 50-ft (metal belt)	96,000
Underflow conveyor (<6 inches) 4- x 35-ft	40,000
Underflow conveyor (<18 inches) 4- x 35-ft	40,000
Disk screen underflow conveyor (-6 inches) 2- x 15-ft	18,000
Disk screen underflow conveyor (-1 inch) 2- x 15-ft	18,000
Magnetic separators (2)	48,000
Disk screen (-6 inches)	31,000
Disk screen (-1 inch)	31,000
Baler (for cardboard)	0[b]
Trommel screen (dual openings 6-inch and 18-inch)	256,000
Miscellaneous bins and containers	0[b]
Magnetic separator feedout conveyor	26,000
Total equipment cost	700,000

[a]Adjusted to Engineering News Record Construction Cost Index of 4118 for March 15, 1984.

[b]No cost, already onboard.

Table 6-2. Total Capital Costs - Alternative 3

Item	Cost Estimate ($)
Equipment shelter enlargement	76,000
Paving[a]	no cost
Equipment	700,000
Site improvements (Alternative 2)	1,650,000
Total	2,426,000

[a]Included in Alternative 2.

Table 6-3. Operating Expenses - Alternative 3

Item	Annual Expense ($)
Waste sorting contract	86,000[a]
Electricity	44,000[b]
Maintenance	35,000[c]
Total	165,000

[a]Based on 1982-1983 contract.

[b]Based on 8 hr/day, 7 day/wk operation, 136 kW connected load, PWC Subic Bay electricity rate of $110/MWh.

[c]Estimated at 5% of equipment cost.

Table 6-4. Total Capital Costs - Alternative 4

Item	Cost Estimate ($)
Semi-mechanized recycling facility (Alternative 3)	2,426,000
Baler	220,000
Total	2,646,000

Table 6-5. Operating Expenses - Alternative 4

Item	Annual Expense ($)
Waste sorting contract	86,000[a]
Maintenance	46,000[b]
Supplies	29,000[c]
Electricity	68,000[d]
Total	229,000

[a]From Alternative 3.

[b]Estimated at 5%, includes Alternative 3.

[c]Baling wire.

[d]Includes Alternative 3 and 75 kW additional connected load for baler.

Table 6-6. Total Capital Costs - Alternative 5

Item	Estimated Cost ($)
Scales	60,000
Incinerator	1,000,000
Residue handling system	100,000
Installation	120,000
Building	1,000,000
Site preparation	100,000
Semi-mechanized recycling facility (Alternative 3)	2,426,000
Total	4,806,000

Table 6-7. Operating Expenses - Alternative 5

Item	Annual Cost ($)
Maintenance (incinerator)	50,000
Electricity (incinerator)	72,000
Waste sorting contract (Alternative 3)	86,000
Maintenance (Alternative 3)	35,000
Electricity (Alternative 3)	44,000
Subtotal	287,000
Fuel oil (supplementary fuel) 116,800 gallons	Not available
Labor 1 part-time supervisor 4 full-time skilled	Not available

Table 6-8. Total Capital Costs - Alternative 6

Item	Estimated Cost ($)
Incinerator system[a]	4,806,000
Heat recovery boiler	350,000
Total	5,156,000

[a]From Alternative 5.

Table 6-9. Capital and Operating Cost Summary

Type	Alternative 1	2	3	4	5	6	7[a]
Capital costs ($)	0	1,650,000	2,426,000[b]	2,646,000[c]	4,806,000	5,156,000	---
Operating expenses ($)	86,000	86,000	165,000	229,000	287,000[d]	287,000[d]	---

[a]Not estimated.

[b]Includes site development of Alternative 2.

[c]Includes Alternative 3.

[d]Does not include supplementary fuel and labor (see Table 6-7).

Section 7

RECOMMENDATIONS AND CONCLUSIONS

Seven alternatives to existing solid waste disposal practices PWC Subic Bay have been presented. Each of these alternatives will be evaluated and compared with respect to the four objectives previously discussed in SECTION 1 of this report:

1. Enhance the physical security of the base

2. Safeguard the reemployment rights of the Negrito workers.

3. Improve the habitability and cleanliness of the base.

4. Increase net revenues to PWC Subic Bay

Implementation of several of the alternatives will require collection of more data by PWC Subic Bay before an engineering design study can commence. Recommendations on collection of these data will be made.

PHYSICAL SECURITY

One of the continuing operational problems of the solid waste collection system at PWC Subic Bay has been the effect of the operation on the physical security of the base. Due to the socio-economic conditions of the adjacent community, the landfilled solid waste residues have become an "attractive nuisance", inducing intruders to enter the base to scavenge this material. One method of discouraging this practice is to devise alternative solid waste processing systems which would reduce or eliminate the attractiveness of the solid waste residues. All seven alternatives discussed in Section 5 perform this function to some extent.

Alternative 1 - Improvement of the Existing Recycling Facility

Since throughput and recycling productivity will be improved, it can be expected that residue volumes will be reduced to some extent.

Alternative 2 - Implementation of the Planned Recycling Facility

Although throughput and recycling productivity will also be improved, the reduction of residue volumes will be similar to Alternative 1.

Alternative 3 - Semi-mechanized Recycling Facility

It is expected that this Alternative will provide a significant improvement in the effectiveness of present practice and Alternatives 1 and 2. Thus, it can be expected that solid waste residue volumes may be reduced by as much as 50%.

Alternative 4 - Semi-mechanized Recycling Facility with Baling

This Alternative combines the residue volume reduction of Alternative 3 with a baling operation which will render the residues unusable to potential scavengers. The acceptability of baling for special wastes such as cigarettes and magazines would need to be negotiated with the suppliers of these products.

Alternative 5 - Semi-mechanized Recycling Facility with Incinerator

This Alternative (and Alternative 6) provides the maximum reduction of solid waste residues. Since the residues are burned in an incinerator, the resultant ashes would have no value to potential scavengers.

Alternative 6 - Semi-mechanized Recycling Center with a Heat Recovery Incinerator

Since this Alternative also uses an incinerator to burn the solid waste residues, the resultant ashes have no value to potential scavengers.

Alternative 7 - Landfill Gas

This Alternative involves the utilization of the existing landfill for gas recovery. Thus, future operation of this Alternative requires continued landfilling of solid waste residues. The attractiveness of the landfill site to scavengers, therefore, will be similar to Alternatives 1, 2, or 3. Also, installation of the landfill gas collection piping system might be an additional "attractive nuisance."

EMPLOYMENT

All of the Alternatives will preserve the present recycling facility jobs of the Negrito contract employees. In fact additional skilled jobs will be created by some of the Alternatives. The fact that all jobs will be preserved and upgraded should be carefully explained to all workers involved.

Alternative 1 - Improvement of the Existing Recycling Facility

No impact on present employment.

Alternative 2 - Implementation of the Planned Recycling Facility

No impact on present employment.

Alternative 3 - Semi-mechanized Recycling Facility

Present jobs will be maintained but upgraded as workers will be involved in less heavy lifting than in the present operation. Some employees may be retrained to perform minor maintenance (i.e., lubrication, etc.). Overall productivity and efficiency will improve.

Alternative 4 - Semi-mechanized Recycling Facility with Baling

Similar impact on employment as Alternative 3. Since a baler is already used in the existing center with cardboard and plastic, use of this equipment by the Negrito employees should not present any problems.

Alternative 5 - Semi-mechanized Recycling Facility with Incinerator

Due to the nature of incineration equipment, operation will require supervision by PWC Subic Bay permanent employees. Negrito contract employees could be trained to perform routine operations and minor maintenance. Additional skilled workers will also be required.

Alternative 6 - Semi-mechanized Recycling Facility with a Heat Recovery Incinerator

Employment impact is similar to Alternative 5.

Alternative 7 - Landfill Gas

Employmen' mpact is similar to Alternative 3 since the Recycling Facility would continue to be operated. Additional skilled employees would be required to operate and maintain the landfill gas pumping and gas utilization equipment.

HABITABILITY AND CLEANLINESS

The appe ` . c of the recycling center and its effects on the habitability and cl anliness of the base are of prime concern to PWC Subic Bay. Potent al environmental effects must also be considered. These effects are summarized in Table 7-1. All of the proposed alternatives are an improvement over existing conditions and have minor environmental impacts.

Alternative 1 - Improvement of the Existing Recycling Center

This alternative would have no negative impacts above the existing operation. Since throughput of solid waste would be improved, odors and other problems related to the aging of solid wastes would be reduced.

Alternative 2 - Implementation of the Planned Recycling Facility

It can be expected that odors would be reduced for the same reasons discussed above. Traffic and noise can be expected to increase in the vicinity of the new center, but this increase would be counteracted by corresponding decreases in noise and traffic at the former site.

Alternative 3 - Semi-mechanized Recycling Facility

External impacts of the facility related to traffic and noise will be the same as Alternative 2 since the site is the same. There will also be a small increase in noise due to the operation of the trommel screen and conveyor belts. Since these devices have a slow rotation speed, these noise increases should be slight. Throughput of solid waste will be substantially increased over the previous alternatives, thus odors will be significantly reduced.

Alternative 4 - Semi-Mechanized Recycling Facility with Baling

Noise will be increased at the Recycling Facility due to the operation of the baling machines. Noise can be reduced by installation of appropriate housings. Odors, blowing papers, and tampering by infiltrators will be substantially reduced at the landfill.

Alternative 5 - Semi-mechanized Recycling Facility with Incinerator

An incinerator would increase air pollution at the incinerator site by an unknown amount, dependent on the design of the incinerator and any ancillary air pollution control equipment. Odors at the landfill site would be substantially reduced since an inert ash would be buried instead of putrescable solid waste residues. Truck traffic to the landfill would also be reduced since the volume to be landfilled would be reduced by an estimated factor of 10 to 1. Disposal of incinerator residues could become a hazardous waste issue if unauthorized hazardous materials enter the waste stream.

Alternative 6 - Semi-mechanized Recycling Facility with a Heat Recovery Incinerator

A heat recovery incinerator would have similar impact as a conventional incinerator. However, it would have an offsetting positive impact in that fuel oil would be displaced.

Alternative 7 - Landfill Gas

Since landfill gas is naturally produced at landfills, recovery of the gas has a positive environmental impact. If landfill gas is not recovered it leaks into the atmosphere, causing odors. Landfill gas can also move laterally through the soil for thousands of feet, surfacing in the foundations of nearby buildings. There are documented cases of explosions and fires in structures built adjacent to abandoned or active landfills. Impacts due to the conversion of landfill gas to energy

would be minor. There would be a beneficial impact due to the reduction in consumption of fuel oil. Extraction of landfill gas would not affect current surface or groundwater impacts from the existing landfill.

Summary of Environmental Impacts

Impacts from all the alternatives considered are minor. In most cases there is a net reduction in environmental impacts compared to the existing operation. Alternatives 6 and 7 offer additional positive environmental impacts due to the displacement of fuel oil.

NET REVENUES

Table 7-2 summarizes net revenues for the Alternatives. All of the Alternatives have a positive revenue flow. The effect on recycling productivity of the improved separation of Alternatives 3 through 6 was estimated as possibly doubling recycled materials recovery. However, since most of the high value recyclable materials are already being recovered, a 25% increase in recycling revenues was assumed. The simple payback (capital cost/net revenue/year) ranged from 4.9 to 19.9 years. Alternative 6 and Alternative 2 had the shortest payback period, 4.9 years. Alternative 5 had the longest payback period, 19.9 years.

ADDITIONAL DATA REQUIRED

Before any of the Alternatives proceed to the preliminary design stage, additional data are required in several areas.

Quantity Data

One of the most important data elements is accurate quantity data in cubic yards and tons for both incoming waste and solid waste residue landfilled. These data can easily be collected by PWC Subic Bay through routine weighing of collection vehicles and refinements in existing record-keeping.

Density

The density of randomly selected truckloads of incoming waste and solid waste residue should be calculated from weight and volume data and recorded on a weekly basis.

Composition

This is a critical data element for the establishment of design criteria for the recycling equipment used in Alternatives 3 through 6. Present PWC Subic Bay records document recyclable materials collected and sold. However, little is known of the actual composition of the incoming waste or the landfilled solid waste residues. Normally a composition study is expensive due to high labor costs for the required manual sorting. However, the solid wastes are being sorted now for

recycling. The portion going to the landfill needs to be characterized. NCEL can design an experimental procedure which could be conducted by the Negrito contract workers under PWC Subic Bay supervision to collect these data. Variations in composition due to season and in-port ships needs to be established as part of this effort.

Energy Content and Proximate Analysis

Energy content of a waste is determined with an oxygen bomb calorimeter; suitability of a waste for combustion is determined by the proximate analysis of moisture, ash, fixed carbon, and volatile combustible matter. Together, these two tests can be used to predict the performance of an incinerator system. NCEL could arrange to have these tests performed at a qualified laboratory.

RECOMMENDATIONS AND CONCLUSIONS

Seven alternative systems for improving solid waste management at the U.S. Facility Subic Bay have been analyzed and reviewed. Table 7-3 summarizes how each alternative meets the objectives of this section. Alternative 4 and Alternative 6 are recommended as most fully meeting these objectives. Although some of the other Alternatives may have shorter payback periods, they do not fully meet the physical security and habitation and cleanliness objectives. It is further recommended that the additional data discussed in this section be collected before proceeding with any of Alternatives 3 through 7.

Table 7-1. Summary of Environmental Impacts

Alternative	Positive Impacts	Negative Impacts
1	Reduction of odors	None
2	Reduction of odors, traffic reduction at old site	Increase in traffic at new site
3	Reduction of odors, traffic reduction at old site	Small noise increase
4	Reduction of odors, and blowing papers at landfill	Small increase in noise above Alternative 3
5	Reduction of odors at land-fill, reduction in truck traffic to landfill	Possible air emissions
6	Reduction of odors at land-reduction in truck traffic to landfill, reduction in fuel oil consumption	Possible air emissions
7	Reduction in landfill gas migration	Possible air emissions from landfill gas engines or boilers

Table 7-2. Net Revenue Summary

Item	Alternative 1	2	3	4	5	6	7[a]
Operating expenses ($)	86,000	86,000	165,000	229,000	287,000[b]	287,000[b]	---
Recycling revenues ($)	422,000	422,000	528,000[c]	528,000[c]	528,000[c]	528,000[c]	---
Energy revenues ($)	N/A[d]	N/A	N/A	N/A	N/A	813,000[e]	---
Net revenues ($)	336,000	336,000	363,000	299,000	241,000	1,054,000	---
Total capital cost ($)	0	1,650,000	2,426,000	2,646,000	4,806,000	5,156,000	---
Simple payback (yr)	N/A	4.9	6.7	8.8	19.9	4.9	---

[a]Not estimated.

[b]Does not include supplementary fuel and labor costs (see Table 6-7).

[c]Assumes 25% increase in recycling revenues (based on extrapolated recycling revenues for October 1982 through June 1983).

[d]N/A = Not applicable.

[e]Energy recovery income could range to $1,545,000/yr resulting in a net revenue of $1,786,000 and a simple payback of 2.9 years.

Table 7-3. Alternative Selection Summary

Objective	Alternative 1	2	3	4	5	6	7
Physical Security	Poor	Good	Better	Best	Best	Best	Better
Employment	No Impact	No Impact	No Impact	No Impact	New Skilled Jobs	New Skilled Jobs	New Skilled Jobs
Habitability and Cleanliness	Good	Good	Better	Better	Best	Best	Better
Increase in Net Revenues[a]	3	3	2	4	5	1	[b]
Overall Ranking[a]	5	4	3	2	6	1	[b]

[a] Ranked highest (1) to lowest (6).

[b] Not evaluated.

REFERENCES

1. Jose S. Quirante. Solid waste improvement plan, Public Works Center. Subic Bay, Philippines, Oct 1982.

2. Contract for garbage, refuse, trash collection and disposal at the U.S. Naval Facility Complex, Subic Bay. Makati, Metro Manila, Philippines Islands, 11 Mar 1983.

3. Hazardous waste management system. Public Works Center. Subic Bay, Philippines, 1982.

4. G. Tchobanoglous, H. Theisen, and R. Eliassen. Solid wastes: Engineering principles and management issues. New York, 1977, pp. 21-27.

5. Trash sorting operation - Briefing for Rear Admiral Smith, Public Works Center. Subic Bay, Philippines, Nov 1982.

6. Contract for trash sorting services at the U.S. Naval Base, Subic Bay, Philippines, Officer in Charge of Contracts. Makati, Metro Manila. Jul 1981.

7. PWC Subic Bay ltr 101:RCC-ebs 5090 Ser 2751 of 23 Nov 1983. Subj: additional data for solid waste resource recovery study, Subic Bay.

8. Utilities restoration program for the Subic-Cubi Naval Complex, Public Works Center. Subic Bay, Philippines. March 1982.

9. E.B. Woodruff and H.B. Lammers. Steam-plant operation. New York, 1967, pp. 80-81.

10. Subic/Cubi kWh consumption report, Public Works Center. Subic Bay, Philippines, Mar 1983.

11. Recycling facility, PWC Subic MILCON Project P-899, Public Works Center. Subic Bay, Philippines, Feb 1981.

12. M. Lingua and J. Zimmerle. A survey of capital, operating, and maintenance costs for starved-air heat recovery incinerators, Naval Civil Engineering Laboratory, Technical Memorandum No. 54-82-12. Port Hueneme, Calif., Sep 1982.

13. Preliminary operating assessment advanced heat recovery incinerator site two, Basic Environmental Engineering, Inc. Naval Civil Engineering Laboratory Contract Report No. CR 83.016. Pottstown, Pa., Sanders and Thomas, Inc., Mar 1983.

14. R.E. Hoffman. "Refuse-to-energy in less than two years," Public Works, Mar 1983, pp. 72-74.

15. Santa Monica waste to energy project; preliminary design report for the Southern California Edison Company, Walnut Creek, Calif., Brown and Caldwell Consulting Engineers. 1982.

16. Field examination of existing heat recovery incinerator (HRI) facilities of up to 50-TPD capacity - Domestic facilities, volume I, Naval Civil Engineering Laboratory, Contract Report CR 84.011. Xenia, Ohio, Feb 1984. (Contract No. N62474-83-C-6708)

DISTRIBUTION LIST

DTIC Defense Technical Info Ctr/Alexandria, VA
NAVFACENGCOM Code 03 Alexandria, VA
NAVFACENGCOM - CHES DIV. Library, Washington, D.C.
NAVFACENGCOM - LANT DIV. Library, Norfolk, VA
NAVFACENGCOM - NORTH DIV. Code 04AL, Philadelphia PA
NAVFACENGCOM - PAC DIV. Library, Pearl Harbor, HI
NAVFACENGCOM - SOUTH DIV. Library, Charleston, SC
NAVFACENGCOM - WEST DIV. Library, San Bruno, CA
PWC Code 101 (Library), Oakland, CA; Code 154 (Library), Great Lakes, IL; Library, Code 120C, San Diego, CA; Library, Guam, Mariana Islands; Library, Norfolk, VA; Library, Pearl Harbor, HI; Library, Pensacola, FL; Library, Subic Bay, R.P.; Library, Yokosuka JA

INSTRUCTIONS

The Naval Civil Engineering Laboratory has revised its primary distribution lists. The bottom of the mailing label has several numbers listed. These numbers correspond to numbers assigned to the list of Subject Categories. Numbers on the label corresponding to those on the list indicate the subject category and type of documents you are presently receiving. If you are satisfied, throw this card away (or file it for later reference).

If you want to change what you are presently receiving:

- Delete – mark off number on bottom of label.
- Add – circle number on list.
- Remove my name from all your lists – check box on list.
- Change my address – line out incorrect line and write in correction (ATTACH MAILING LABEL).
- Number of copies should be entered after the title of the subject categories you select.

Fold on line below and drop in the mail.

Note: Numbers on label but not listed on questionnaire are for NCEL use only, please ignore them.

Fold on line and staple.

DEPARTMENT OF THE NAVY

NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA 93043

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300
1 IND-NCEL-2700/4 (REV. 12-73)
0930-LL-L70-0044

POSTAGE AND FEES PAID
DEPARTMENT OF THE NAVY
DOD-316

U.S.MAIL

Commanding Officer
Code L14
Naval Civil Engineering Laboratory
Port Hueneme, California 93043

DISTRIBUTION QUESTIONNAIRE

The Naval Civil Engineering Laboratory is revising its primary distribution lists.

SUBJECT CATEGORIES

1 **SHORE FACILITIES**
2 Construction methods and materials (including corrosion control, coatings)
3 Waterfront structures (maintenance/deterioration control)
4 Utilities (including power conditioning)
5 Explosives safety
6 Construction equipment and machinery
7 Fire prevention and control
8 Antenna technology
9 Structural analysis and design (including numerical and computer techniques)
10 Protective construction (including hardened shelters, shock and vibration studies)
11 Soil/rock mechanics
13 BEQ
14 Airfields and pavements
15 **ADVANCED BASE AND AMPHIBIOUS FACILITIES**
16 Base facilities (including shelters, power generation, water supplies)
17 Expedient roads/airfields/bridges
18 Amphibious operations (including breakwaters, wave forces)
19 Over-the-Beach operations (including containerization, materiel transfer, lighterage and cranes)
20 POL storage, transfer and distribution
24 **POLAR ENGINEERING**
24 Same as Advanced Base and Amphibious Facilities, except limited to cold-region environments
28 **ENERGY/POWER GENERATION**
29 Thermal conservation (thermal engineering of buildings, HVAC systems, energy loss measurement, power generation)
30 Controls and electrical conservation (electrical systems, energy monitoring and control systems)
31 Fuel flexibility (liquid fuels, coal utilization, energy from solid waste)
32 Alternate energy source (geothermal power, photovoltaic power systems, solar systems, wind systems, energy storage systems)
33 Site data and systems integration (energy resource data, energy consumption data, integrating energy systems)
34 **ENVIRONMENTAL PROTECTION**
35 Solid waste management
36 Hazardous/toxic materials management
37 Wastewater management and sanitary engineering
38 Oil pollution removal and recovery
39 Air pollution
40 Noise abatement
44 **OCEAN ENGINEERING**
45 Seafloor soils and foundations
46 Seafloor construction systems and operations (including diver and manipulator tools)
47 Undersea structures and materials
48 Anchors and moorings
49 Undersea power systems, electromechanical cables, and connectors
50 Pressure vessel facilities
51 Physical environment (including site surveying)
52 Ocean-based concrete structures
53 Hyperbaric chambers
54 Undersea cable dynamics

TYPES OF DOCUMENTS

85 Techdata Sheets
86 Technical Reports and Technical Notes
82 NCEL Guide & Updates
☐ None— remove my name
83 Table of Contents & Index to TDS
91 Physical Security

PLEASE HELP US PUT THE ZIP IN YOUR MAIL! ADD YOUR FOUR NEW ZIP DIGITS TO YOUR LABEL (OR FACSIMILE), STAPLE INSIDE THIS SELF-MAILER, AND RETURN TO US.

(fold here)

DEPARTMENT OF THE NAVY

NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA 93043-5003

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300
1 IND-NCEL 2700/4 (REV. 12-73)
0930-LL-L70-0044

POSTAGE AND FEES PAID
DEPARTMENT OF THE NAVY
DOD-316

Commanding Officer
Code L14
Naval Civil Engineering Laboratory
Port Hueneme, California 93043-5003

END

FILMED

7-85

DTIC